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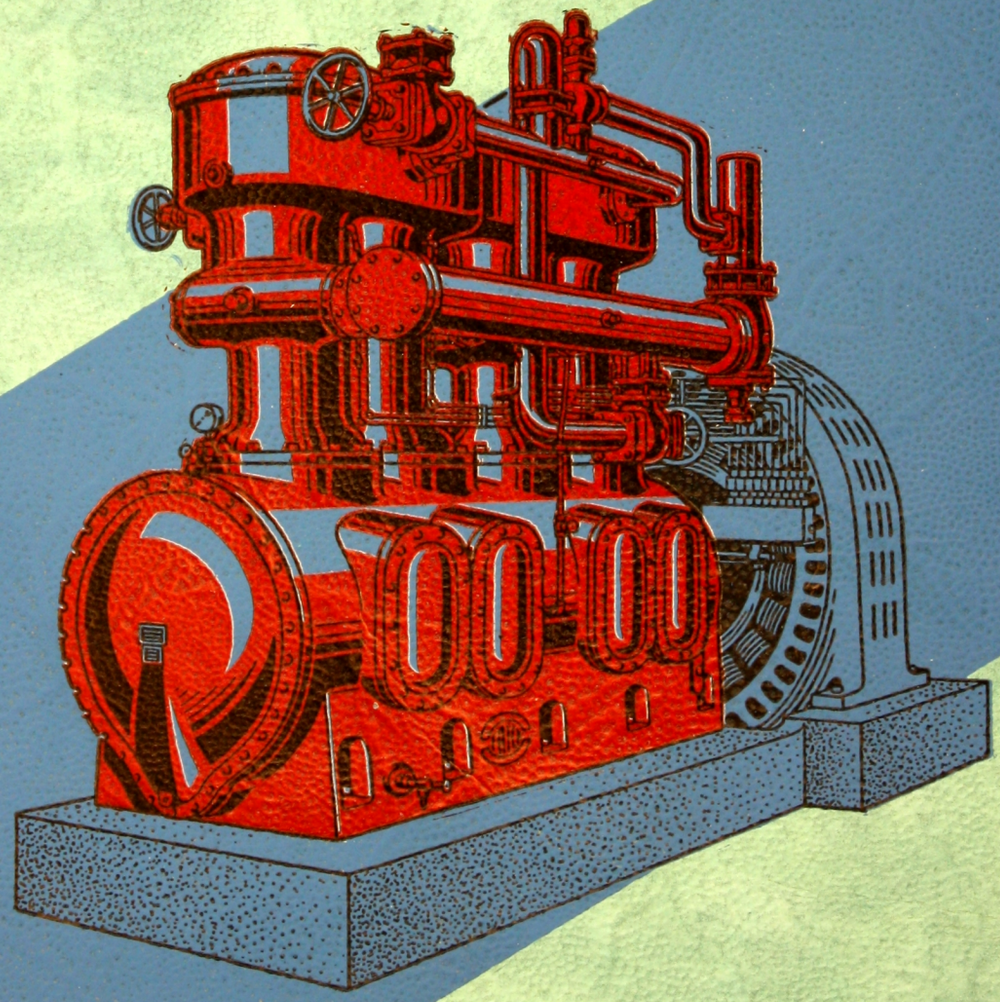
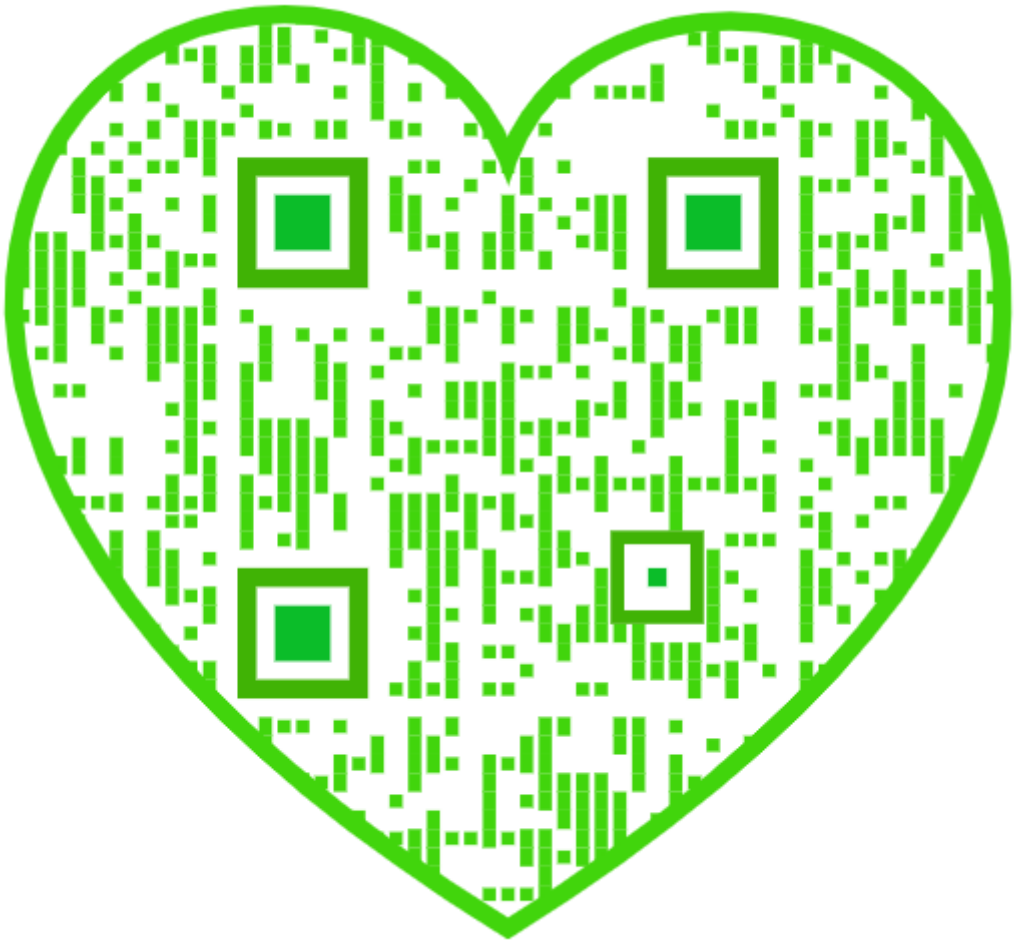
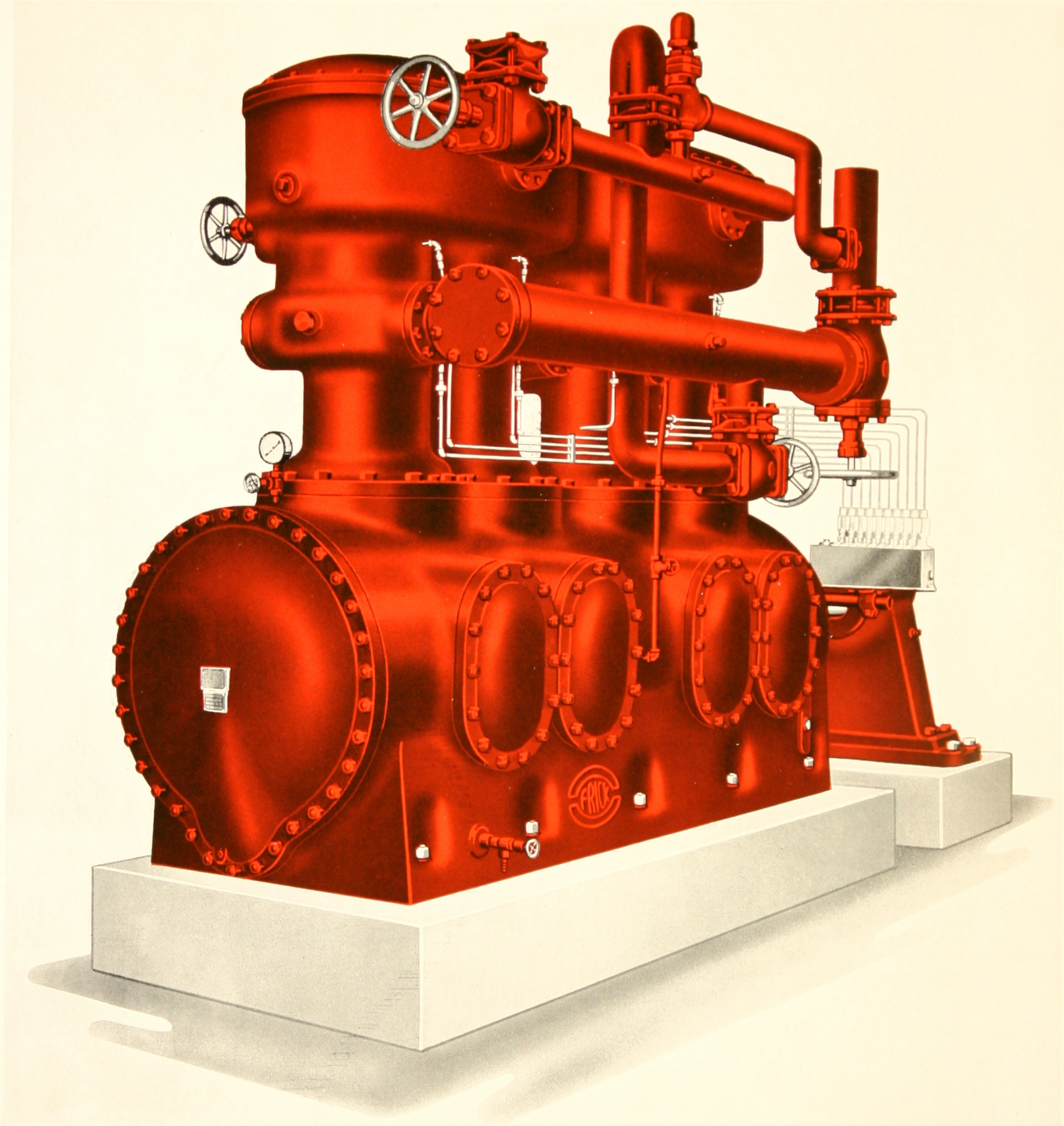


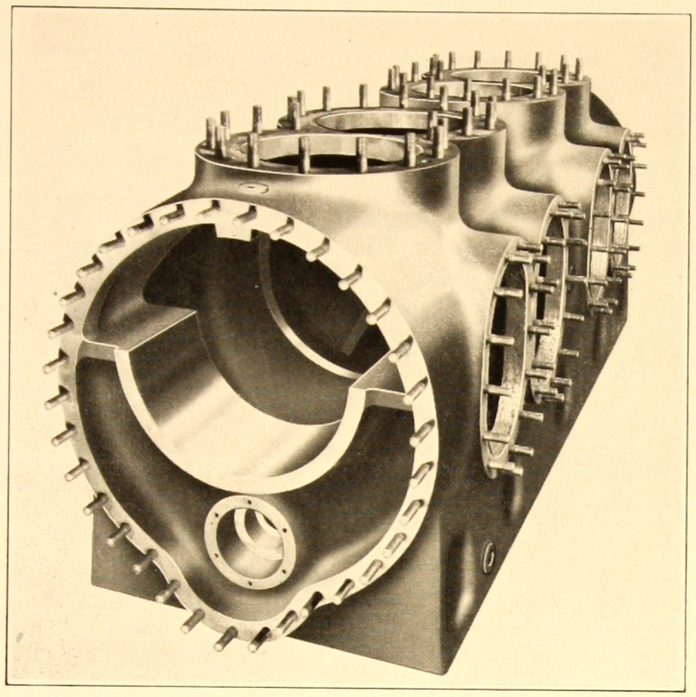
Bulletin No. 651-A

Large Four-Cylinder Compressors





The Four-cylinder Frick Compressor, with its advanced design, compact arrangement, and attractive maroon finish, is the last word in large refrigerating machines. View shows standard by-pass arrangement. Note capacity control.



The Crankcase is a One-piece Casting, Reinforced with Stout Ribs and Cross Braces, and Fitted with Four Manholes on each side.

signed for regular ammonia work. Outline dimensions and other details are given on the last page of this bulletin.

To meet special requirements, these machines can be furnished with one pair of cylinders made larger than the other two. Such an arrangement is useful for carrying loads at two separate levels. The larger cylinders can be designed to serve as boosters handling low-temperature gas, and discharging through inter-coolers to the smaller high-pressure cylinders, thus providing a vertical two-stage machine. Eight or ten such combinations are available.

In use, the machines require the very minimum of attention, and will operate continuously for months without being stopped for adjustments. Built for the heaviest service, their smooth-running qualities are apparent wherever these compressors have been installed. Both the general design and the perfection of details are based upon our experience since 1882 in building all types and sizes of commercial and industrial refrigerating equipment.

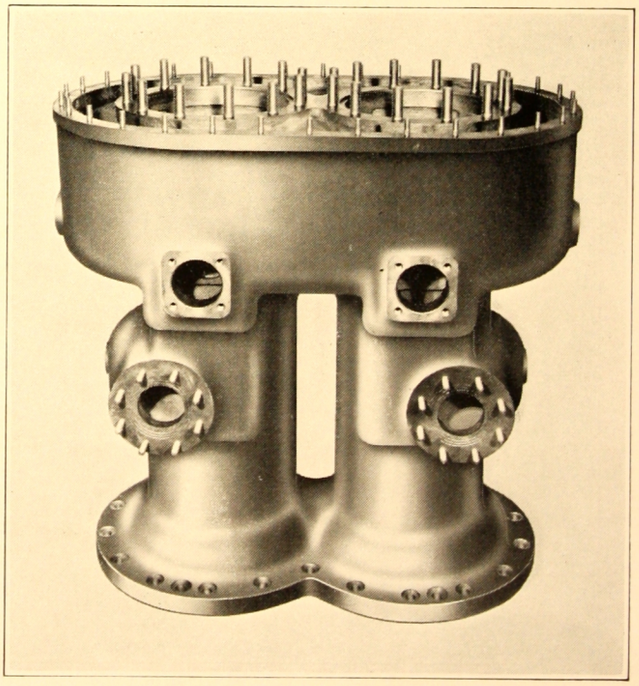
CRANKCASE

The crankcase of the four-cylinder compressor is a heavy one-piece casting of special alloy semi-steel.

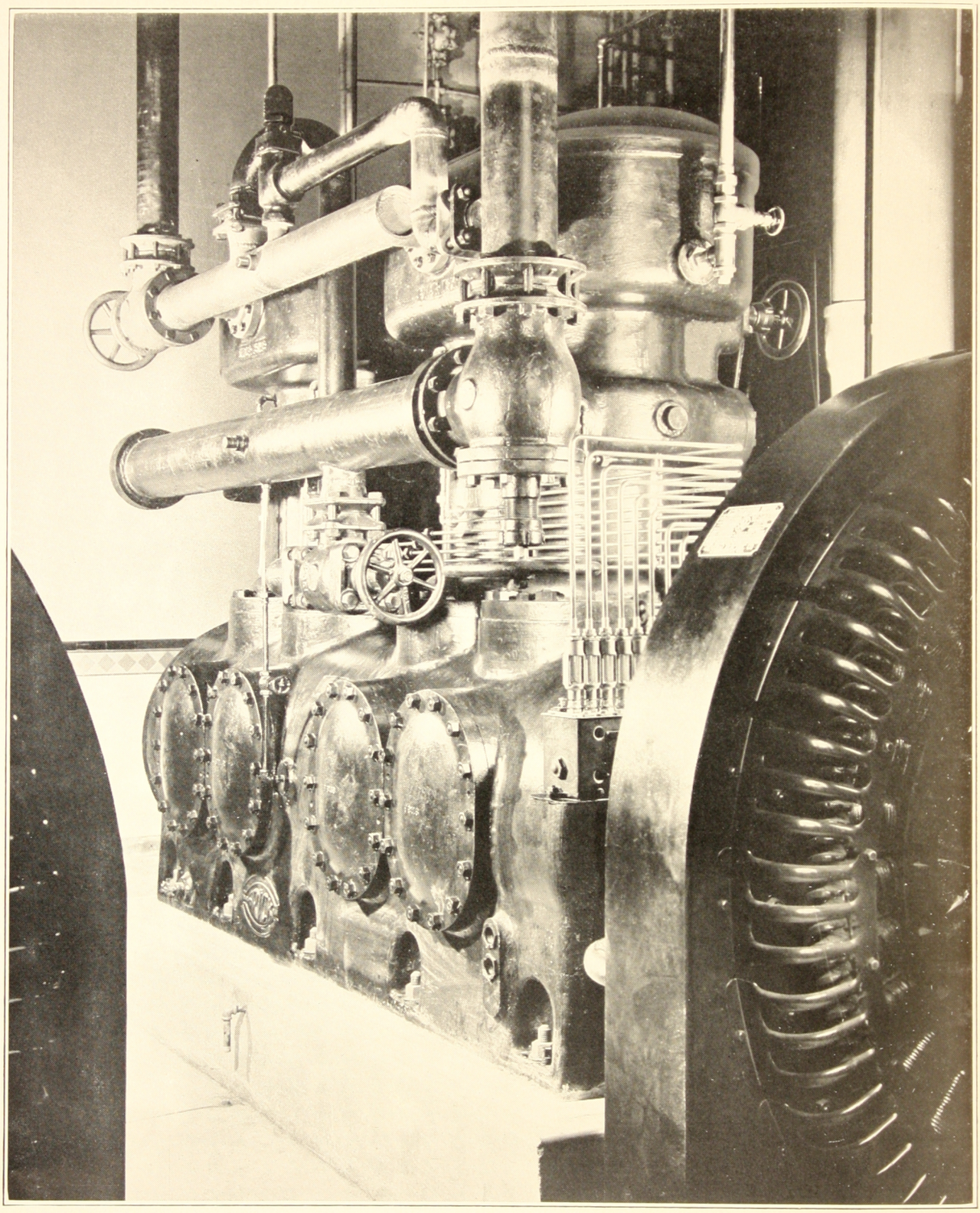
The castings are sand blasted, and after being machined are tested both hydrostatically and with air pressure, under water. Stout ribs reinforce the casting at many points: openings are provided in the cross ribs to permit the flow of oil by gravity to the force-feed pump. Four large manholes are provided on each side to permit easy access to the crankshaft and connecting-rod bearings. Three heavy saddles for supporting the bearings, one at each end and one in the center, are cast integral with the crankcase.

CYLINDERS

The four cylinders are cast in pairs of two each, and are mounted in line above the crankcase. Suction gas is drawn into all four of the cylinders, and is discharged into the condenser line, at each revolution of the shaft.



Semi-steel Cylinder Block, as used on the Frick Four-cylinder Compressor. Observe the Large Water Jacket which Completely Encloses the Heads and Discharge Gas Passages, on all except the Booster and Freon-12 Machines, which do not Require Jacketing of the Cylinder Heads.



One of two 12″ by 12″ four-cylinder Compressors installed at the Brewery of C. Schmidt and Sons, Philadelphia. These produce a total of 300 tons of refrigeration running at moderate speed and pressures, and occupy the floor space formerly taken up by one steam-driven machine of only 40 tons capacity.

The metal used in pouring the cylinder castings is a special semi-steel that has been developed after years of research and experience with many thousands of compressor frames. The mix is held under rigid scientific control by daily tests in the laboratory, the iron being maintained at just the right density, strength, and hardness to resist wear. The same high-grade metal is employed in making the crankcase, pistons, belt wheel, outboard bearing, and various smaller parts. All castings are made in our own foundry, which is one of the finest and best equipped in the country.

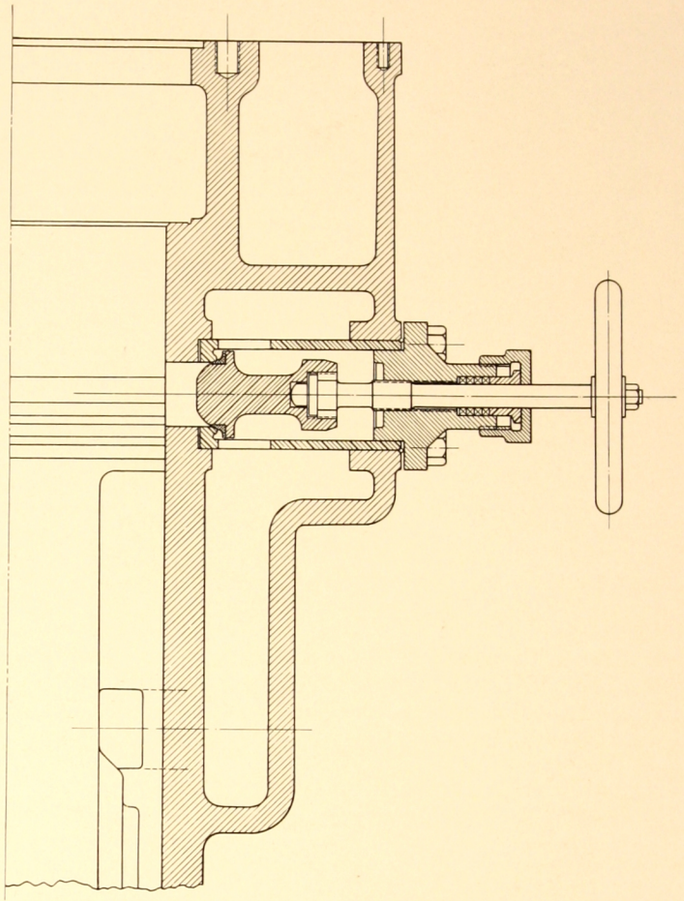
After being carefully bored on a mill with a 6-in. boring bar, supported at both ends, the cylinders are honed to a mirror finish on a machine made especially for the work. This machine, built in our own shops and for years the largest of its kind in existence, hones the cylinders while in a vertical position.

The walls of the cylinders are made amply thick to permit reboring. Each pair of cylinders is surrounded at the top by a water jacket, the cover of which completely encloses the cylinder heads (on all except the 15″ by 10″ and 17¾″ by 12″ machines.) This arrangement not only keeps the heads cool but gives access to the water space for cleaning.

Clearance has been reduced to a practically negligible amount. To insure complete filling of each cylinder at every stroke of the piston, two inlet ports are provided, and the suction manifold has been made oversize.

Each block of cylinders is fastened with 22 bolts to the crankcase, which has wide pads provided for the purpose; on most sizes the cylinders are flared at the base, just above the flange, to insure extra stability under the heaviest loads. Four stout dowel pins hold each set of cylinders in permanent alignment.

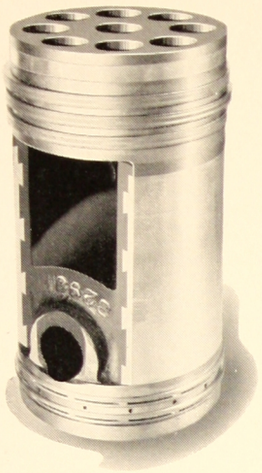
The outside of each cylinder is enveloped by a suction gas passageway of ample size, connecting the manifold to the two suction ports in the wall of the cylinder. This passageway is provided with flanges at each end, permitting the use of double suction connections when desired. The passageways are also tied in with the capacity control valves described in the next paragraph.



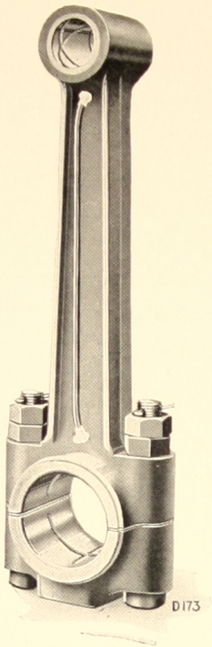
Showing Construction of the Capacity Controls Furnished with the Four-cylinder Machine. Opening the Valve Provides a Bypass from the Middle of Cylinder to the Suction Ports.

CAPACITY CONTROLS

Are fitted to each cylinder to handle varying loads. When one of the control valves is opened it uncovers a port in the wall of the cylinder, which permits part of the gas to flow back into the suction. The port is so spaced as to reduce the capacity of that cylinder by one half, or 50 per cent. As the machine has four cylinders, the effect of opening the control pocket on one cylinder is to cut out one half of one fourth of the total capacity, or 12½ per cent. When two of the controls are opened, the machine delivers 75 per cent of its rating. When running with three control valves open, it gives 62½ per cent: with all four valves open the capacity is of course 50 per cent. This series of reductions will take care of all usual changes of load in plants large enough to have these big compressors.



Accurately Machined Piston, with Babbitted Thrust Surfaces. The Top Rings are also Babbitted.



Connecting Rod, Showing Crank Bearing, Wrist Pin Bushing and Oil Pipe.

SAFETY CYLINDER HEADS

These machines are built with safety cylinder heads of the same type used on all Frick vertical ammonia compressors. The heads are spring loaded, permitting them to lift in case slugs of liquid ammonia enter the cylinders, thus preventing injury to the compressor.

By the use of these safety heads, and of properly designed valves, wasteful clearance space is safely eliminated.

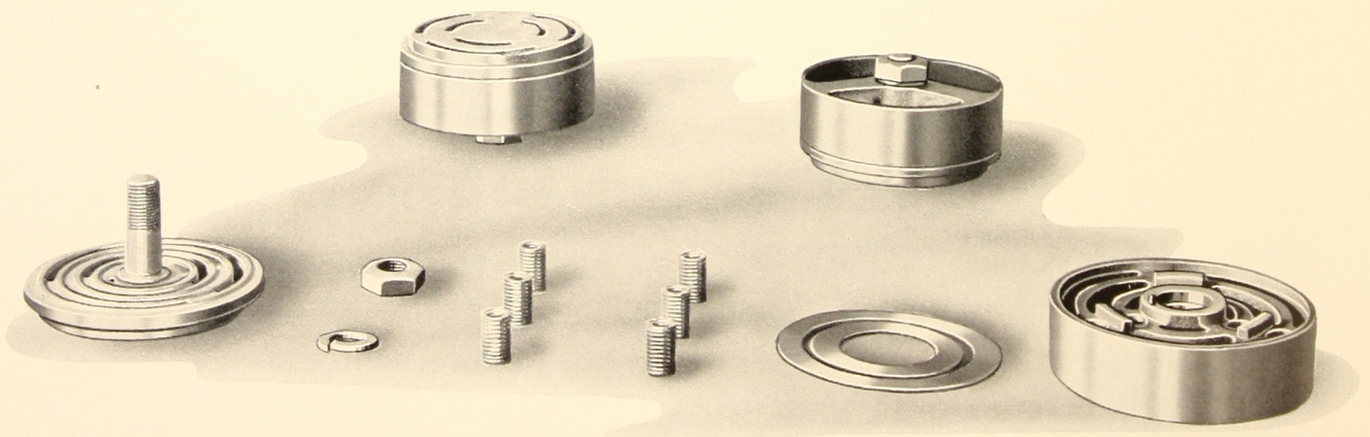
DISCHARGE VALVES

The discharge valves are mounted in the safety heads, and are of the ring-plate type, developed especially for this service. The valves, constructed with light moving parts, are quiet, tight, and reliable. The ring plates, of which there are two in each valve cage, are heat-treated to give the longest useful life. When the ring lifts, the gas discharges at both sides throughout its circumference. The 10″ by 10″ machine has three complete sets of discharge valves in the head; the 11″ by 10″ has four sets; the 12″ by 12″ has five sets; the 15″ by 10″ has seven; and the 17¾″ by 12″ has nine.

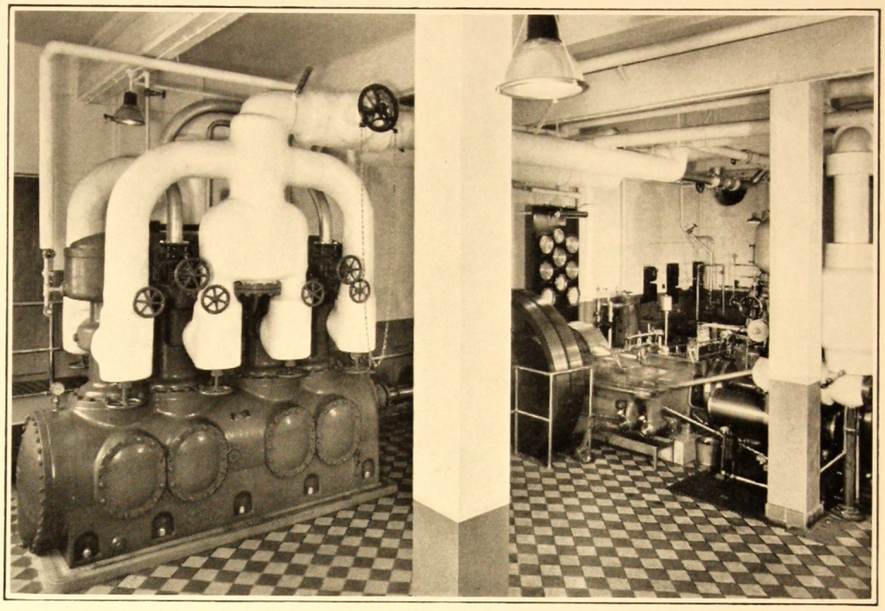
PISTONS

These are built with sufficient length to keep the suction ports uncovered throughout the stroke. A dome-shaped web above the piston pin separates from the crankcase the part of the piston through which the suction gas passes. Below this partition are the two oil scraper-type rings used to prevent oil pumping: above it are the three compression rings. American Hammered piston rings are standard equipment.

Each piston is babbitted at the surface where the load is applied, thus giving the effect of the old-time crosshead. Babbitt-inserted compression rings are also employed. This construction, together with the honed cylinder walls, make the machine run for years without appreciable wear.



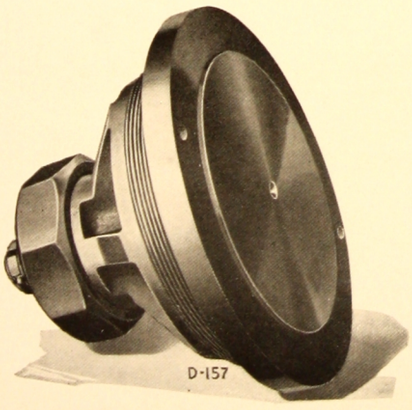
The Discharge Valves are Mounted in the Safety Head and are of the Ring-Plate Type, Developed Especially for this Service.



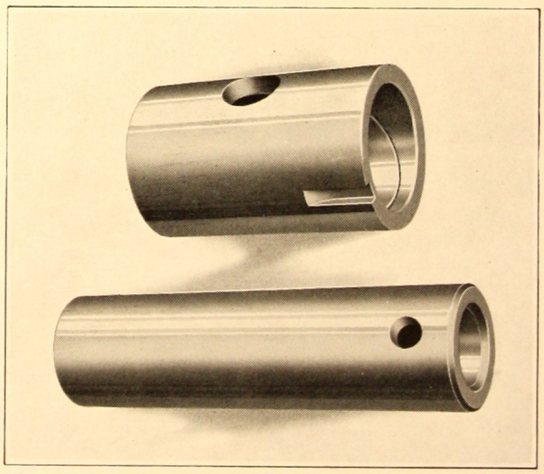
Four-cylinder Frick 12″ by 12″ Compressor at the Pfeiffer Brewery in Detroit, where Three other Large Frick Machines have been in Service for Years. Note Double Suction Connections and Handwheels for Capacity Control Valves.

SUCTION VALVES On the smaller machines the suction valves are of the poppet type, floated by springs: the motion is also cushioned by dash pots. Each valve cage is threaded, screwed into the piston and securely pinned. (No tap screws to work loose.) The multiple construction makes for lighter, faster-acting valves and provides the most ample gas passages. The 15″ by 10″ and 17¾″ by 12″ machines have ring-plate valves to handle the large quantities of low-pressure gas.

PISTON PINS The piston pins are made extra large. The pins on the 12″ by 12″ machine, for example, have a diameter of 5 inches. They are made of case-hardened steel; each one is closely inspected and is Rockwell tested for hardness. The hollow design of the pin aids lightness. The bushings are of cast iron, tightly secured in the connecting rods, and are grooved to facilitate the flow of oil. An opening through the bottom of the bushing admits the oil to the grooves and pressure surfaces.



Multiple Suction Valves are Screwed into the Piston Heads and Securely Pinned.



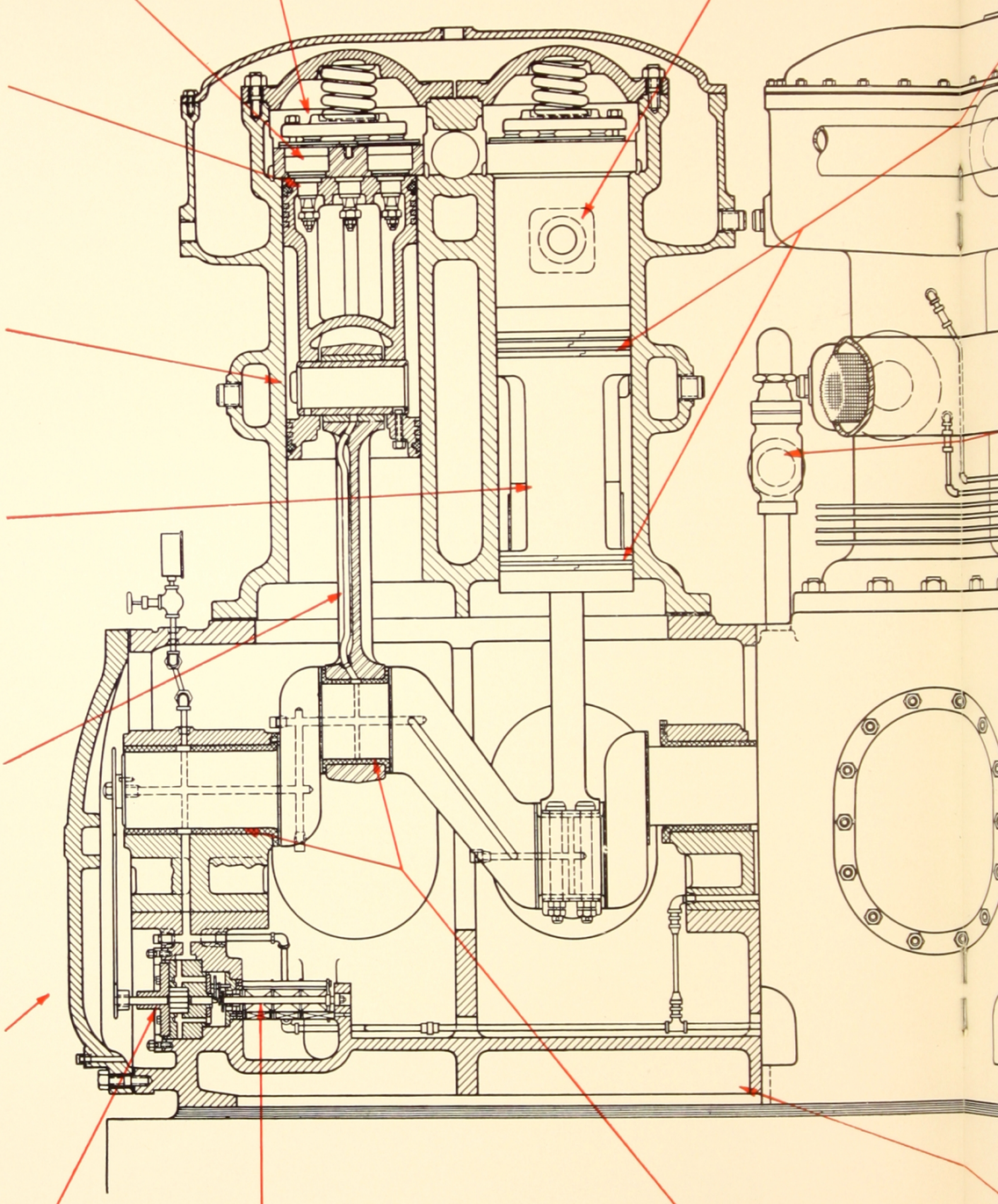
Bushings and Piston Pins are both Made Extra Large. Pins are Drilled through the Center for Lightness.

Discharge valves are of the ring plate type, constructed with light moving parts; they are quiet, tight, and reliable.

Cylinder heads, held down by springs, lift in case slugs of liquid enter cylinder. Wasterful clearance space eliminated.

Capacity control is furnished on each cylinder. Capacity of machine can be varied in steps of 100%, 87½%, 75%, 62½% and 50%.

Suction valves are of the multiple poppet type and are floated by springs; the motion is also cushioned by dash pots. (15″ by 10″ and 17¾″ by 12″ machines use ring plate suction valves).



Separate suction ports to each cylinder permit free gas passage. Dual suction connections, one on each side, when desired.

Pistons are made of semi-steel, with ample babbitted thrust surfaces, accurately ground to size.

Connecting rods are of drop-forged steel, H-section, and are made long to lessen side thrust on the pistons.

End cover plate encloses oil pump and filter. Crankshaft is admitted through either end of the machine.

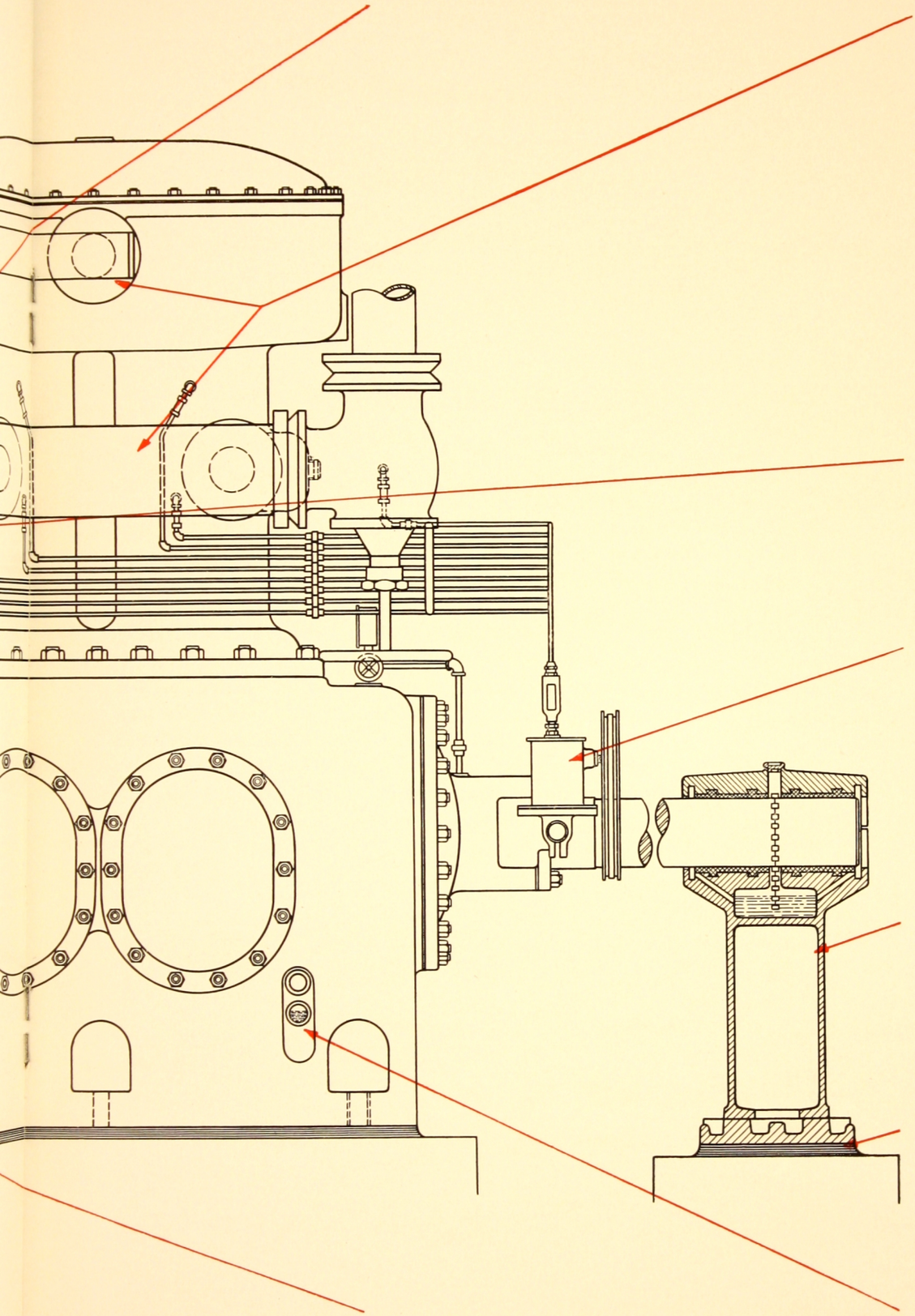
Internal oil pump, driven by roller chain, provides force-feed lubrication to all bearings and to shaft seal.

Mechanically driven self-cleaning Cuno filter purifies oil. Filter plates are cleaned every 30 seconds.

Crank bearings are of improved type, with shim adjustment. Shaft bearings are die-cast of heavy-duty babbitt. Split sleeves allow renewal without removal of shaft.

Top of each piston carries three babbitt-inserted compression rings, while the bottom has two oil-scraper rings.

Manifold and by-pass fabricated of steel pipe. Special manifolds made for every purpose.



The stuffing box is made double length, and holds pressure with the packing gland nuts only finger tight. Frick Flexo-Seal furnished on special order.

Safety relief valve prevents injury to crankcase from excessive pressure.

9-Point force-feed lubricator supplies oil to wall of each cylinder at two places, and to the suction of the compressor.

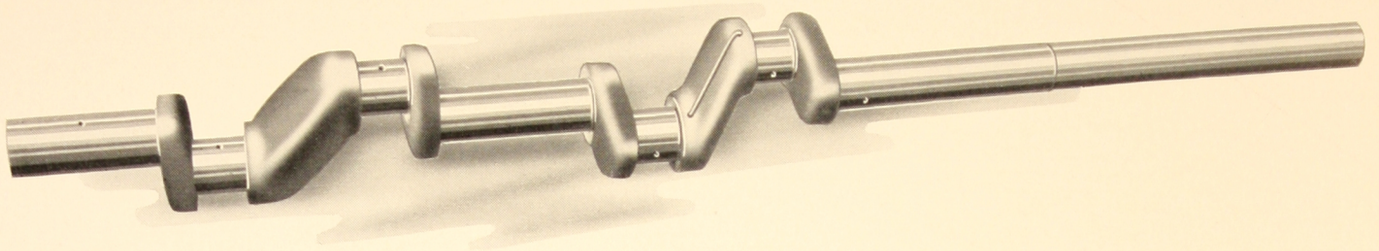
Standard drive is through synchronous motor or V-belt wheel. Direct-connected steam, gas, or oil engine, or any special drive, readily applied.

Chain-oiled outboard bearing supports weight of motor, or flywheel and pull of belt. Bearing lined with heavy-duty babbitt.

Separate base plate under outboard bearing pedestal permits removal of bearing and wheel without disturbing concrete.

Crankcase is a heavy one-piece casting of semi-steel, reinforced with stout ribs, assuring permanent alignment.

Two oil sight glasses allow checking of the oil level while the compressor is in operation.



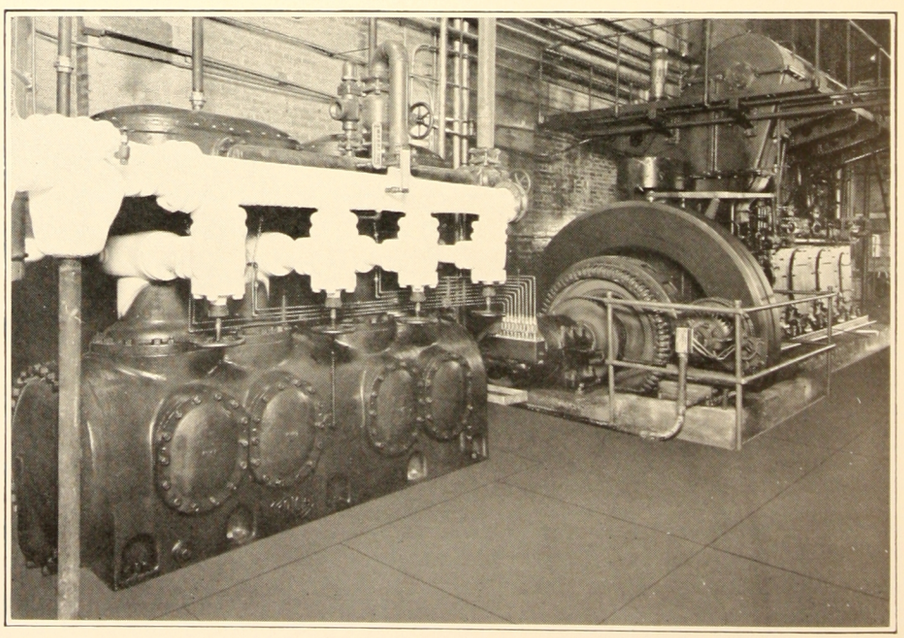
The Crankshaft, of Drop-forget Steel, is 6″ in Diameter (7″ for the Heavier Machines) and has the Throws Arranged to Give a Pressure Stroke every Quarter Turn, or Four Pumping Strokes per Revolution.

CONNECTING RODS

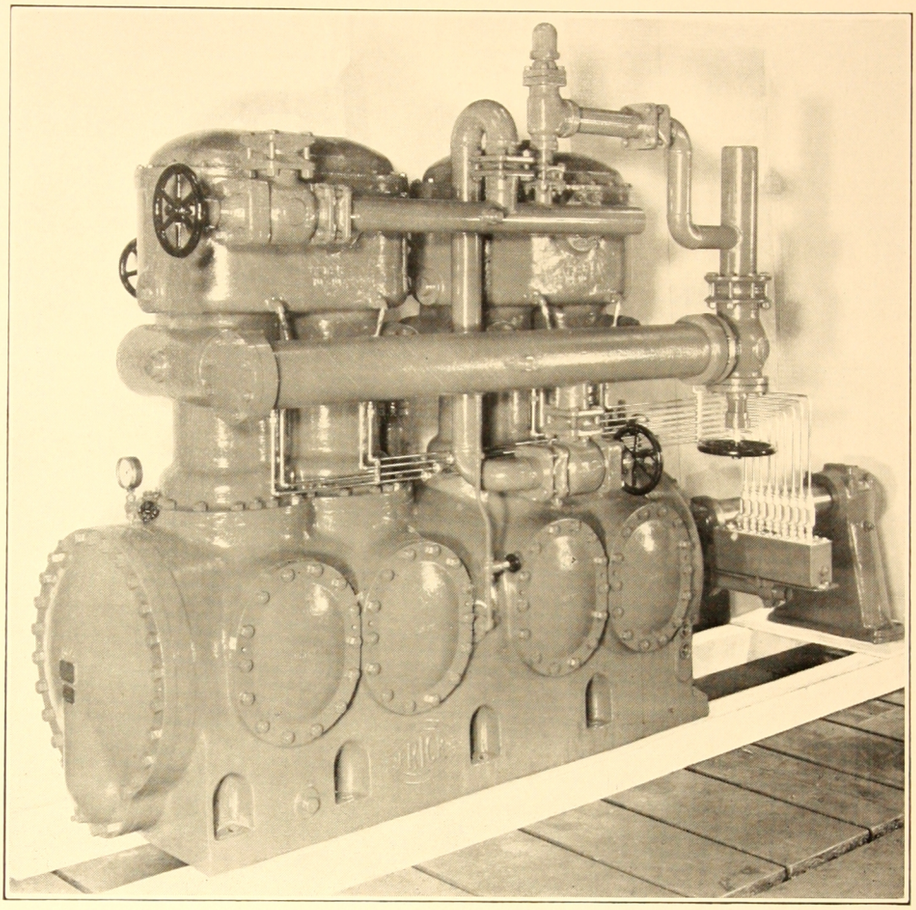
Are made extra long, to lessen the side thrust on the pistons. The rods are of drop-forged steel, formed in an H-section, and are many times stronger than actually required for the moderate speeds at which the compressors are operated. The rod is bored at the upper end to receive the wrist pin bushing: this is of cast iron, made extra large, and is pressed into the rod. The lower end of the rod after being bored is sawed apart to form the marine type bearing for the crank: the two halves are held together by four bolts, made of chrome-vanadium steel and fitted with lock nuts and pins.

CRANKSHAFT

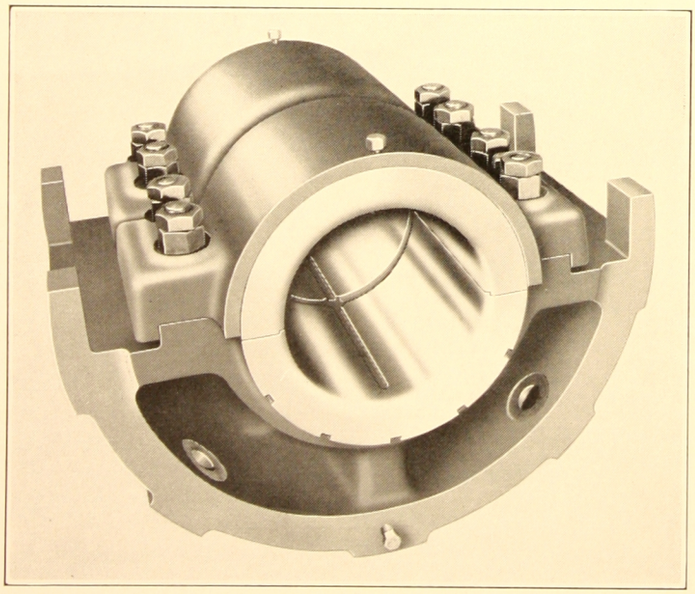
The shaft is drop-forged from the best grade steel and is heat-treated for toughness. It is made oversize for rigidity and to give larger bearing surfaces. The shaft on the 12″ by 12″ machines is 7 in. in diameter at the main bearing and 6¾ in. at the outboard bearing; it is 16 ft. in length or longer, depending on the type of drive. See table on page 16 for sizes of shafts. The bearing surfaces are machined and then ground accurately to size. The pairs of cranks on the shaft are at right angles to each other as shown in the photograph. The adjacent cranks in each pair are placed 180 degrees apart. This arrangement not only gives balanced operation but spaces the four compression strokes evenly throughout one revolution of the shaft.



Four-cylinder 12″ by 12″ Frick Compressor Direct-connected to a 560-hp. Diesel Engine, which also Drives a Large Generator: Midwest C. S. and Ice Co., Kansas City



Four-cylinder 10″ by 10″ Machine, Photographed in the Frick Shops.



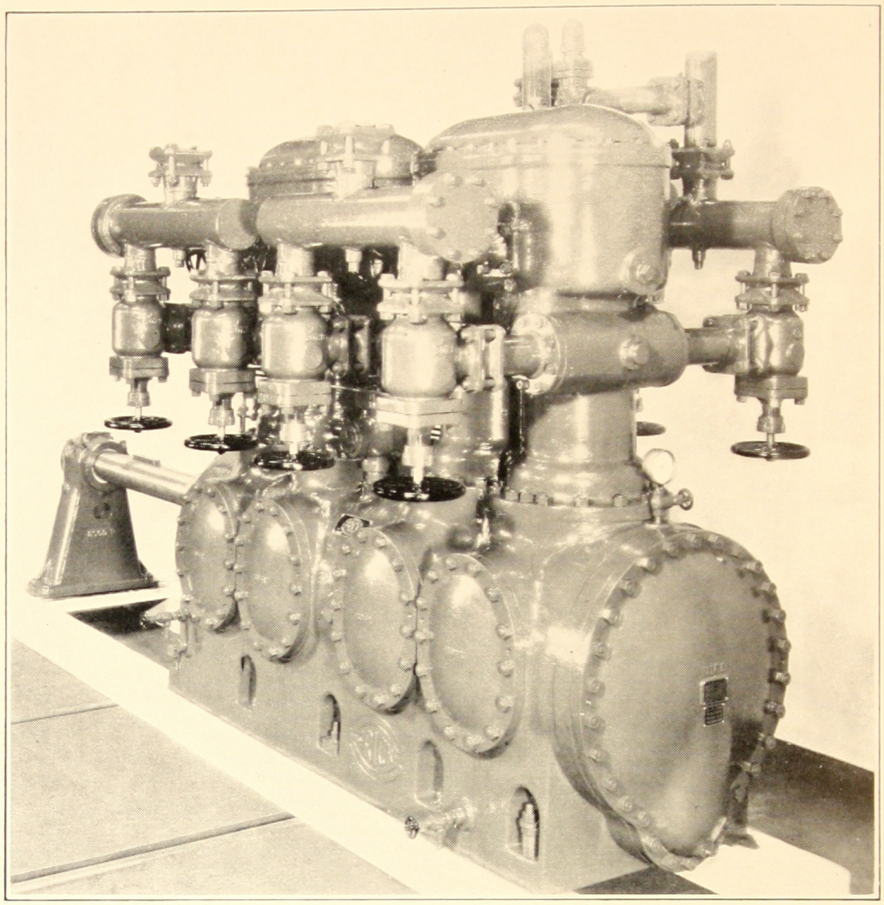
The Main Shaft Bearings have the Sturdy Design Shown Above, Halves being Supported by Heavy Bearing Yokes.

BEARINGS

Both the main and connecting rod bearings are die-cast of best grade heavy duty babbitt, containing no lead. The shaft bearings are of the split type, allowing them to be replaced without removing the crankshaft. The three main bearings are secured by bolted caps, as illustrated. The main bearings are made interchangeable.

OUTBOARD BEARING

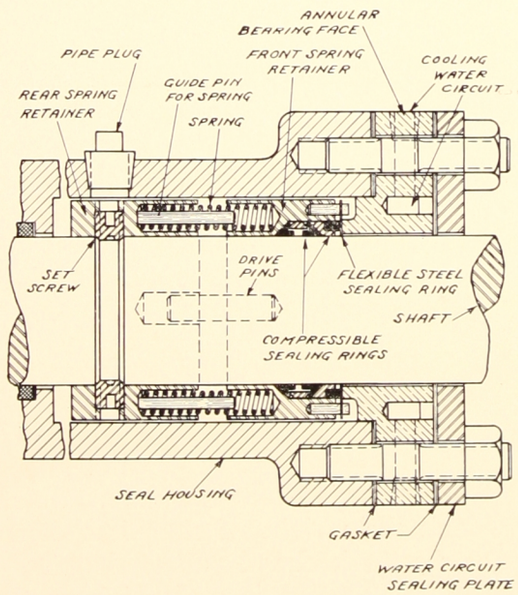
The outboard bearing pedestal is cast of semi-steel; bearing metal of best grade heavy duty babbitt is poured in place. This bearing supports the weight of the direct-connected motor, or the flywheel and pull of the belt. The pedestal of the bearing is made high enough to permit removal of the rotor or flywheel without disturbing the foundation.



11″ by 10″ Compressor with Four Cylinders, Ready for Shipment. Double Suction Connections were Furnished in this Case.

STUFFING BOX

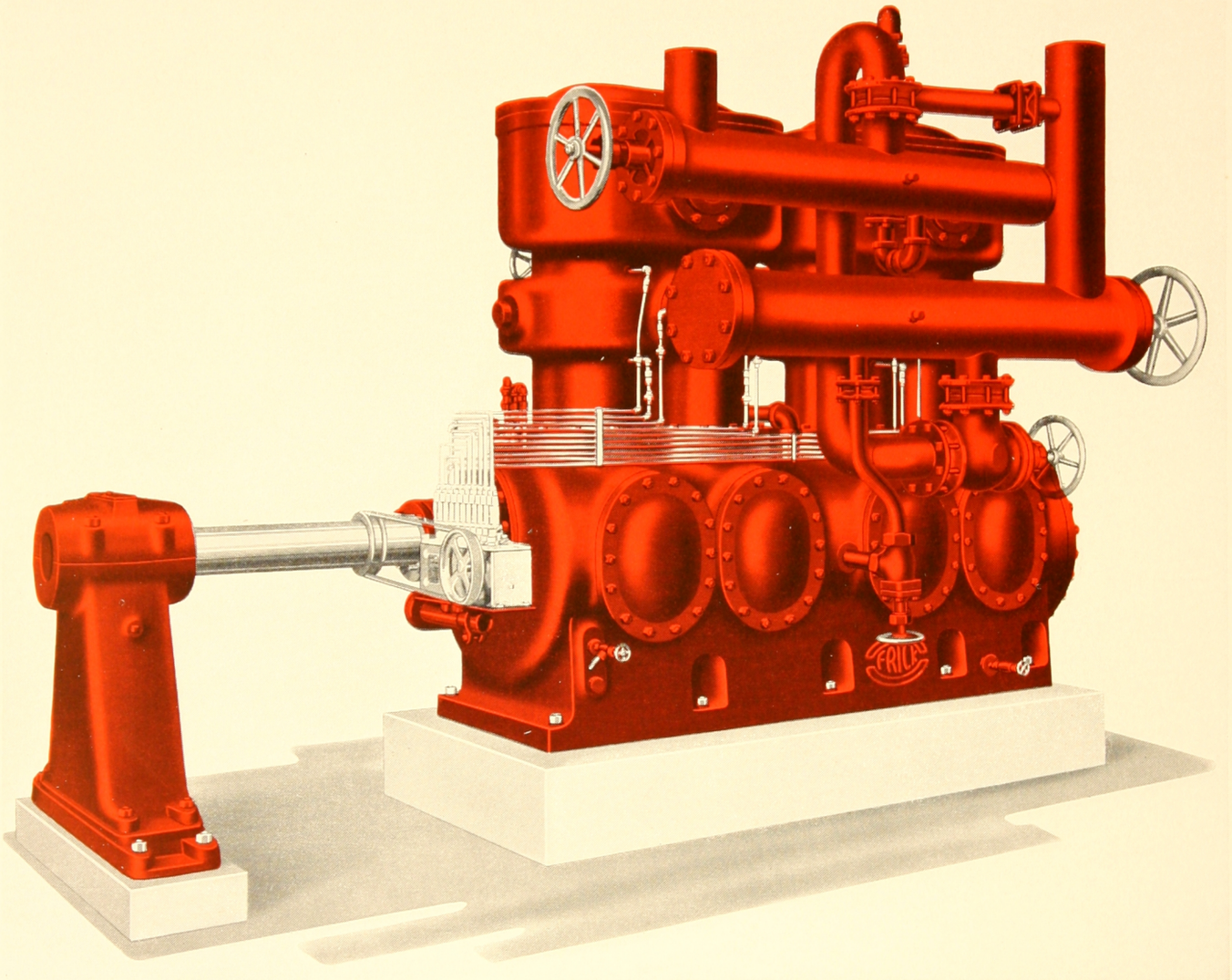
The stuffing box is made double length, and holds the crankcase pressure with the packing gland nuts only finger tight. The shaft runs in oil, the box being kept flooded by the automatic lubricating system. The oil lantern is made in the form of a spring, making constant adjustments unnecessary.



The Patented Frick Flexo-Seal is Furnished as Extra Equipment, When Ordered.

THE PATENTED FRICK FLEXO-SEAL

is furnished on these compressors by special order. This Seal replaces the usual stuffing-box packing, and requires no attention when in use. The Flexo-Seal holds either pressure or a vacuum with equal ease, and has proved its ability to prevent leakage on hundreds of large Frick Freon-12 compressors, subjected to the most trying service. (Holding ammonia is a simple matter in comparison with holding Freon-12.)

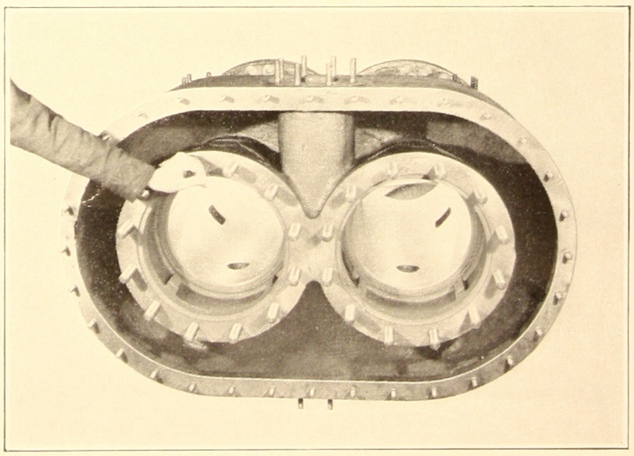


Four-cylinder 15″ by 10″ Compressor, Designed for Freon-12 or Ammonia Booster Service.

DRIVE These compressors are readily arranged for various types of drives. The drive may be by direct-connected synchronous motor; by flat or V-belts; by steam, oil, or gas engine; or by tandem-coupled or special plans.

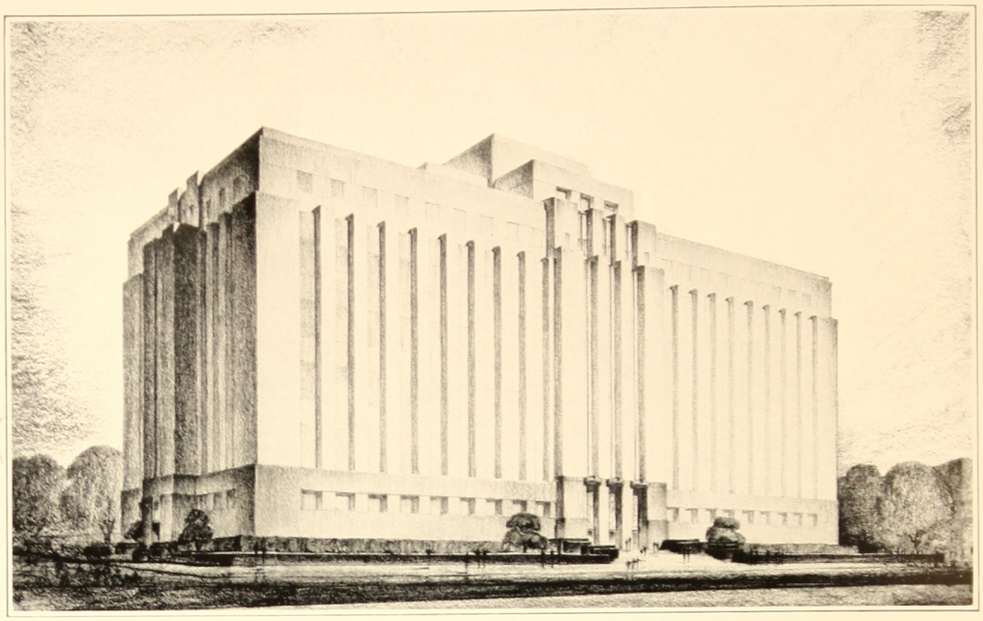
LUBRICATION The moving parts of the compressor are lubricated by means of a pressure oiling system which is unusually thorough, the oil being filtered and kept in circulation continuously.

The oil drains into the bottom of the crankcase and collects around the pump, the suction of which, together with the filter, is submerged in the oil, so as to be constantly primed and free from gas binding.



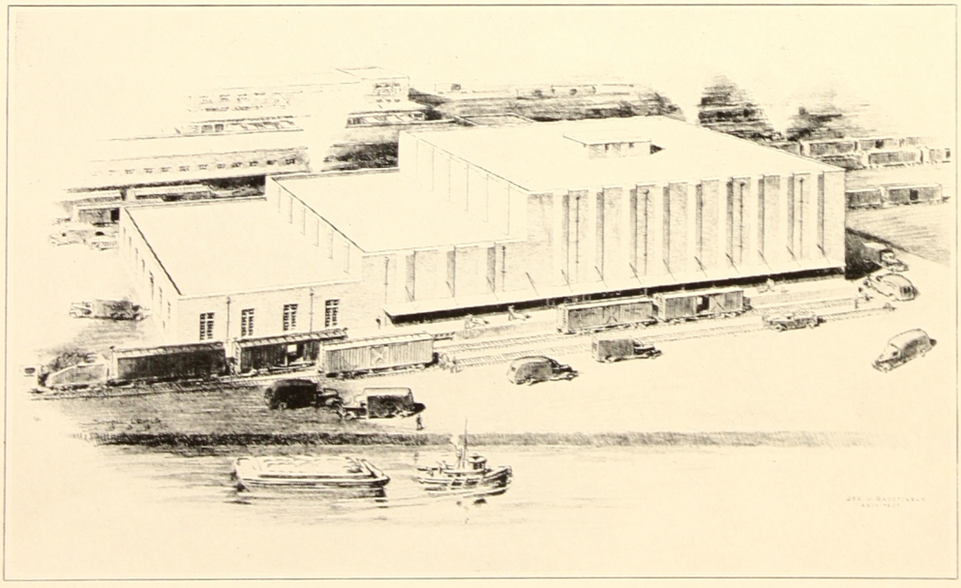
The Cylinder Walls are Honed to a Mirror Finish. Note Ports for the Suction Gas and Capacity Controls.

The Bankers Life Building, at Des Moines, is Air Conditioned Throughout with the Aid of Three 15″ by 10″ Freon-12 Machines; Two of these are the Four-cylinder Type, while the other has Two Cylinders.



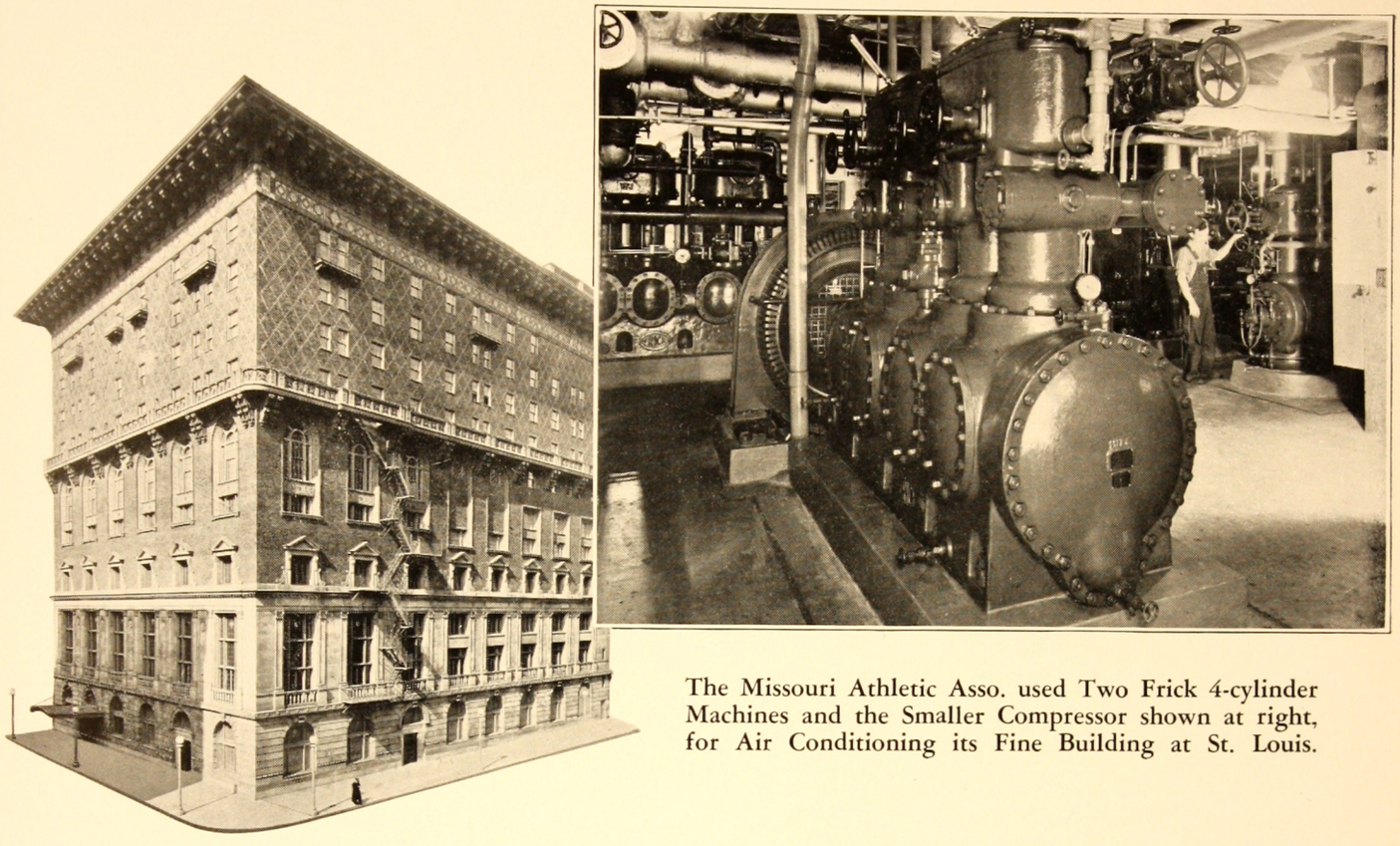
The filter is of the Cuno type, with three batteries of thin steel plates; the plates are spaced only a minute distance apart, and are made to revolve slowly past the cleaner or comb by a train of gears. This device offers a constantly cleared passage for the incoming oil.

The geared oil pump and the filter cleaner are driven by a chain and sprockets, which are completely enclosed by the housing plate at the outer end of the crankcase. This pump is arranged so that with an easily made adjustment it will operate properly in whichever direction the main shaft is rotated. Instructions for making the change are given on a brass plate attached to the housing just mentioned.



This Big New Food Market and Terminal at Kansas City, Kan., makes 160 Tons of Ice Daily and Cools 1¼ Million Cu. Ft. of Storage Space with Three Frick Four-Cylinder Compressors and a Large Two-cylinder Machine.

The oil is drawn from the crankcase by the pump and is forced into the rear main bearing. A gauge is connected with the bearing to show the pressure of the oil leaving the pump. Some of the oil goes through the passage, drilled in the crankshaft, to the connecting rods, and thence to the piston pins. The rest of the oil fed to the main bearing enters a ¾-in. pipe which connects with



The Missouri Athletic Asso. used Two Frick 4-cylinder Machines and the Smaller Compressor shown at right, for Air Conditioning its Fine Building at St. Louis.

the middle and the front main bearings. A smaller pipe is connected from the front main bearing to the stuffing box. In this line there is connected a pressure gauge and an oil check valve.

The check valve is set at 40 lb. above crankcase pressure. When the pressure exceeds that amount the excess oil is passed back into the crankase. The oil after lubricating the bearings runs into the crankcase and is used over again.

A Madison-Kipp 9-point lubricator is also furnished to feed oil to the wall of each cylinder, in two places, on the thrust side. The remaining oil feed line goes to the suction of the comprssor, to supply oil for the valves.

The outboard bearing is lubricated by a chain oiler; the chain turns with the shaft, and carries up oil from the reservoir, which is of large size, in the pedestal.

Frick refrigerating machine oil No. 4 (the heaviest weight) is recommended for use in these compressors.

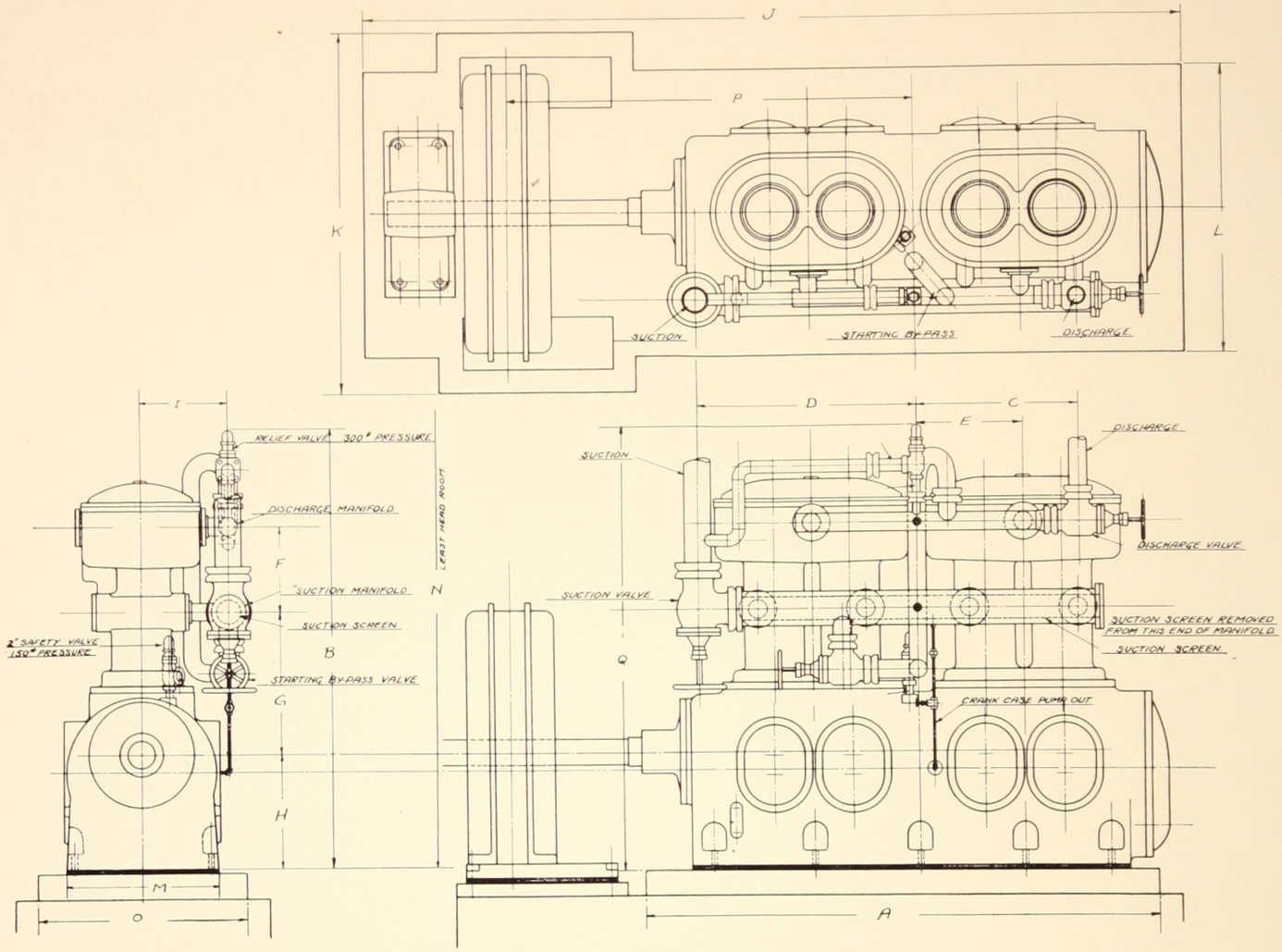
MANIFOLDS AND CONTROL VALVES

The suction manifold is of welded construction, and is made of steel pipe joined to welding-neck flanges. Branches of large size lead to each of the four cylinders.

The main suction stop valve, is built into the end of the manifold. A suction screen nearly 3 feet long is inserted in the manifold from the opposite end, and is made removable for cleaning.

The discharge manifold is made of extra heavy steel pipe. It carries the 2-inch safety relief valve and piping from this valve to the suction line, in addition to the bypass connection. This last is of 4-inch size, and is furnished with a valve conveniently placed at the bottom for the use of the engineer.

The main stop valves use the patented Frick high-angle seat, which holds the gas pressure with greater ease than any other type known to us. Refer to Frick Catalog K for a complete description of this superior valve design.



Principal Dimensions of Large Frick Four-Cylinder Compressors

Cylinder Size	10 x 10	11 x 10	12 x 12	15 x 10	17¾ x 12
Size Main Suction Connection	5″	5″	6″	8″	
Size Main Discharge Connection	3½″	3½″	4″	6′-8″	
Jacket Cooling Water Connection (2 of each)	2″	2″	2″	¾″	¾″
Diameter of Shaft at Main Bearing	6″	6″	7″	6″	7″
Diameter of Shaft at Motor or Wheel	5¾″	5¾″	6¾″	5¾″	6¾″
Size Bypass Connection	3½″	3½″	4″	5″	
Length of Suction Screen	33″	33″	33″	33″	
Dimension A	8′-6″	8′-6″	10′-2¼″	8′-6″	10′-2¼″
B	8′-4″	8′-4″	9′-4″	7′-11″	9′-6″
C	34¼″	34¼″	40″	33¼″	
D	48¼″	48¼″	54¾″	36¾″	
E	21⅝″	21⅝″	26¼″	21⅝″	26′-¼″
F	18⅛″	18⅛″	21⅜″	17¾″	19⅛″
G	30¼″	30¼″	35¾″	28½″	35¼″
H	25″	25″	28½″	25″	28½″
I	18½″	18½″	22″	25½″	
J (Using Synchronous Motor Drive)	14′-9″	14′-9″	16′-8″	15′-0″	16′-8″
K (Using Synchronous Motor Drive)	6′-6″	6′-6″	8′-0″	7′-6″	8′-0″
L	5′-0″	5′-0″	5′-4″	5′-0″	5′-4″
M	31″	31″	38″	31″	38″
N	11′-2″	11′-2″	12′-6½″	10′-0″	12′-3″
O	4′-0″	4′-0″	4′-4″	4′-0″	4′-4″
P	7′-2½″	7′-2½″	7′-11″	7′-3″	7′-11″
Q	8′-5″	8′-5″	9′-5″	8′-0″	9′-7″

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Figures given are not to be used for construction purposes.

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